

### The Resource

The most valuable fishery in the southeastern United States is the harvest of penaeid shrimp. In South Carolina and Georgia, this fishery is comprised of two species, the white (*Litopenaeus setiferus*) and brown (*Farfantepenaeus aztecus*) shrimps, with white shrimp dominating catches. Pink shrimp (*F. duorarum*) also occur but are a minor component of commercial catches in SC. Along the Atlantic coast, the brown and pink shrimp comprise the bulk of the commercial harvest in North Carolina, but are proportionately less important in South Carolina and Georgia. Brown shrimp landings are similar in South Carolina, Georgia, and along Florida's east coast. Pink shrimp landings are substantial only in Florida among these three states (Table 1). This disparity in the geographic distribution of pink shrimp is due at least in part to the presence of seagrass beds in North Carolina and Florida, which serve as primary nursery areas for juvenile pink shrimp. South Carolina and Georgia have almost no seagrass beds.

Table 1. Average commercial trawl landings (metric tons) reported by state, 1979-2002. (National Marine Fisheries Service (NMFS) Landings website)

	Brown shrimp	Pink shrimp	White shrimp
North Carolina	2,080	755	434
South Carolina	832	6	1,871
Georgia	521	8	2,453
Florida	315	127	1,186

Commercial shrimp trawling in South Carolina occurs primarily from Winyah Bay to the Georgia border. Currently, trawling is limited to nearshore areas and some areas just inside the coastal sounds and bays. With an exception during World War II, South Carolina bays and sounds were closed to trawling until the early 1950s to minimize impacts on other recreational and commercial fisheries and to protect shrimp in nursery areas. In the mid-1950s, the Department of Natural Resources, then the Wildlife and Marine Resources Division, opened selected sounds to trawling between August 15 and December 15. Restrictions were placed on trawling in rivers and creeks to minimize the harvest of juvenile shrimp that were generally too small to be commercially valuable.

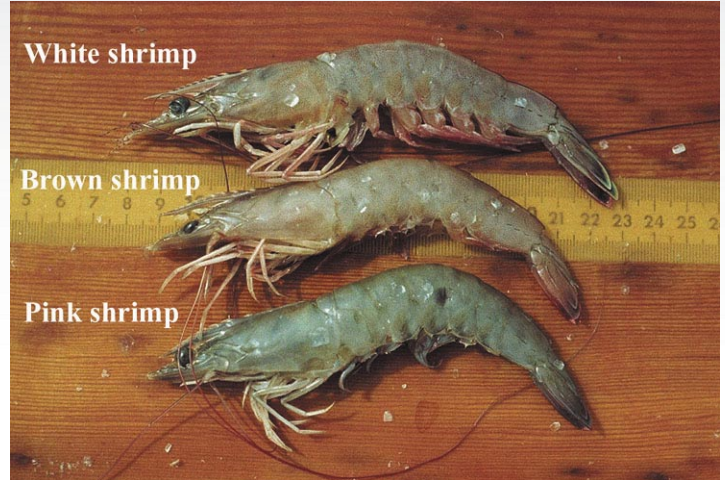


Figure 1. The three species of commercially important penaeid shrimp that occur in South Carolina.

Shrimp is South Carolina's principle fishery, with estimated average commercial and recreational shrimp landings of 4.6 million pounds per year. The long history of this fishery in SC has resulted in extensive economic and social components, with families depending on commercial shrimp-ing for generations. The white shrimp was the first of the penaeid shrimps to be commercially marketed for food.

### Habitat and Biology

White shrimp begin spawning offshore along the South Carolina coast in May and June, with a few spawning events occurring as late as August. White shrimp spawned in late summer comprise the "overwintering" shrimp, which barring cold winters, become the spring spawning "roe" shrimp the next year.

During mating, the male transfers a packet of sperm to the female, who attaches it to her underside. Eggs are fertilized externally as they are broadcast into the water. White shrimp eggs sink to the ocean floor, and after 12 to 24 hours they hatch into planktonic larvae which go through 10 larval stages and a postlarval stage that resembles the adult. About three weeks after spawning, the postlarvae enter estuaries in currents generated by tides and wind and migrate upstream to nursery areas (Figure 2). Recruitment of white shrimp to South Carolina estuaries occurs from May to September, with peak recruitment in late May and early June.

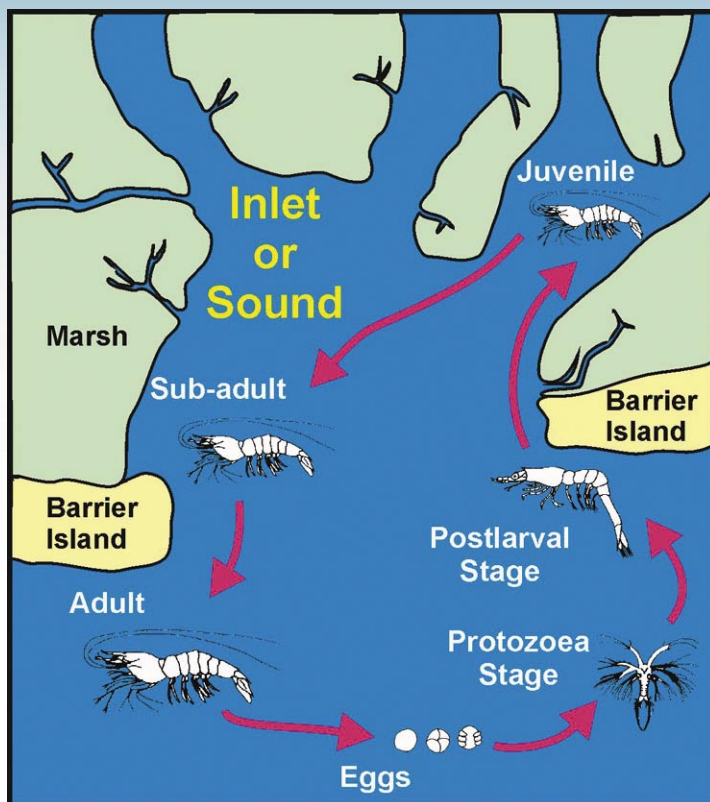


Figure 2. Life cycle of white shrimp in SC.

Once in the estuary, young shrimp move into tidal creeks, where they find ample supplies of food and protection from predators. During high tide, juvenile shrimp move to the marsh surface, where they are protected among the dense vegetation. They feed on a variety of organic material including small benthic worms, plant matter, and decaying animals. White shrimp are opportunistic feeders, consuming any food that is available, including other shrimp. At low tide, shrimp move off the marsh surface and are concentrated in the channels of tidal creeks. Shrimp abundance and distribution is dependent on rainfall and winter water temperatures. Adult and juvenile shrimp are most abundant in salinities ranging from 8 - 15 ppt (25 - 40 % of oceanic salinity). During periods of heavy rain, individuals leave shallow tidal creeks and move into the deeper, more saline waters of the rivers and harbors of the estuary.

Shrimp remain in these nursery habitats until late summer, when they begin to move into larger creeks and rivers, and then offshore to form the late summer-fall crop. During this migration, they move progressively down the estuary into more saline waters. White shrimp are also known to make coastwide migrations of considerable distance, moving south down the Atlantic coast during winter and returning in spring.

Besides being important as food and bait for people, studies have shown that white shrimp are very important consum-

ers of algae and microscopic animals, and the shrimp serve as prey for many species of fish, including sea trout, red drum and flounder.

The other two species of penaeid shrimp inhabiting South Carolina waters have similar life histories to the white shrimp but their seasons are different. Brown shrimp spawn offshore during the fall and spring and generally recruit to South Carolina estuaries as early as February, with peak movement into the estuary occurring in March-April. Post-larvae and juveniles are associated with shallow vegetated habitats over a wide range of salinities. They grow as the water warms up, then move back toward the ocean, being harvested recreationally by seining and cast netting in the rivers, and commercially in the ocean and lower sounds by shrimp trawlers in June through August.

The spawning period of pink shrimp overlaps that of white shrimp and occurs during the spring and summer. Both white and brown shrimp prefer the muddy bottom habitats that are characteristic of South Carolina estuaries. Pink shrimp, on the other hand, favor a sandy/shell bottom. While the latter type of habitat occurs in South Carolina estuaries, it is not as widespread as muddy and sandy habitats. This may explain the lower abundance of pink shrimp relative to white and brown shrimp in South Carolina waters.

The penaeid shrimp resource in South Carolina waters is closely monitored, and its harvest is regulated by the South Carolina Department of Natural Resources. Because the SCDNR has the authority to regulate shrimping seasons, the Marine Resources Division has sampled shrimp populations since 1979, following the work of Robert Lunz begun at Bears Bluff Lab on Wadamalaw Island in the early 1950s, then by the Wildlife Department in the late 1960s. In the late 1970s, general methods for sampling shrimp were standardized, productive locations were established, and the survey remains ongoing. The goals of the fishery independent monitoring program are:

- To collect fishery independent and fishery dependent data on commercially and recreationally important penaeid shrimp.
- To analyze population trends, life history patterns, and interpret environmental effects on shrimp populations.
- To interact with resource users, managers, and scientists in order to facilitate the proper management of the penaeid shrimp resource that will sustain the fishery and maintain healthy stocks.

## Sampling Methods

### *Fishery Independent*

The primary gear used to monitor the shrimp populations year round in estuaries of South Carolina is a twenty-foot wide, one-inch mesh trawl towed from a fifty-foot research vessel. Locations in Charleston Harbor and the Wando and Ashley Rivers are usually sampled twice a month. Areas south of Charleston lying near the Intercoastal Waterway, including the North and South Edisto Rivers, St. Helena, Port Royal, and Calibogue Sounds are sampled in March, April, June, August, October, and December (Figure 3). This sampling allows close monitoring of spring white shrimp, summer brown shrimp, and fall and overwintering white shrimp.

At each station, the trawl is towed for 15 minutes. The catch is sorted for white, brown, and pink shrimp as well as blue crab and horseshoe "crab". Excessively large catches are subsampled by removing a representative smaller quantity, with the larger portion returned to the water. This

ensures survival of most of the catch, which includes many species of fish and invertebrates. Shrimp are weighed, counted, measured, and noted for obvious signs of disease. The number of tails per pound is counted to determine "count" or grade. When white shrimp are nearing spawning, their stage of maturity is also noted. Information collected by these trawls is compiled at the Marine Resources Center and made available to SCDNR fisheries managers. Queries from the public, especially fishermen, are routinely addressed with recent catch information. Trawl information gathered each year is compared and forms the basis of this report.

The trawl samples are supplemented by samples collected in tidal creeks using outboard motorboats with a 10-foot trawl, primarily around Charleston in spring and summer, and a 20-foot trawl in areas north of Charleston (Winyah, North Santee, and Bulls Bays) in summer and fall. This information is used by SCDNR when opening the channel net fishery near Georgetown. Information collected in tidal creeks provides size, relative growth, and abundance data on shrimp in these primary nursery areas. Creek sampling

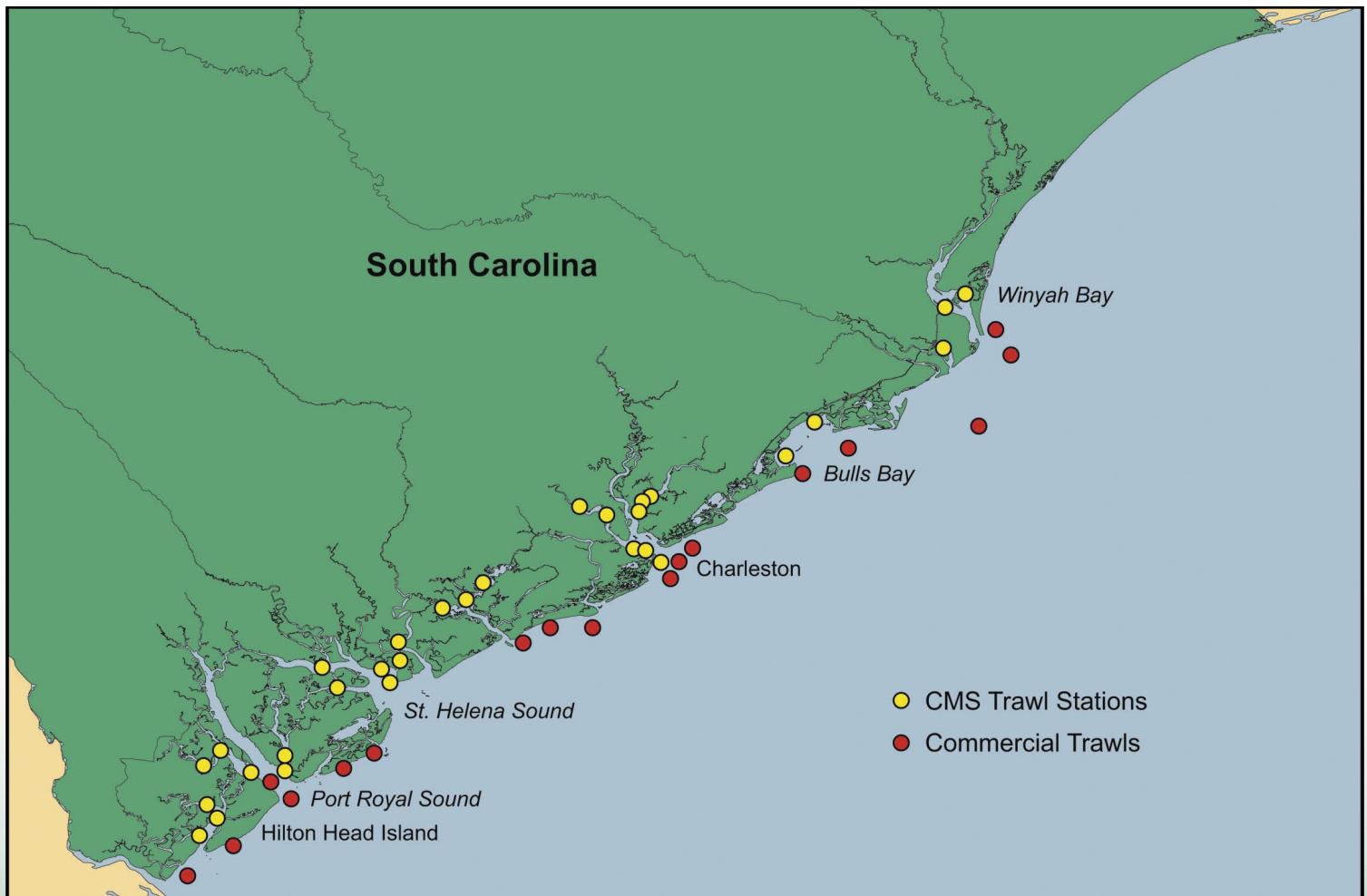


Figure 3. Location of fishery dependent and fishery independent (CMS) trawl stations along the coast of SC.



data have proven useful to document immigration, and emigration, relative abundance, and growth of juvenile shrimp in shallow creek habitats, thus allowing projections of when shrimp will reach harvestable size.

Sampling of shrimp in nearshore areas has been conducted since 1989 as part of the Southeast Area Monitoring and Assessment Program (SEAMAP). The SEAMAP trawl survey covers the coastal zone between Cape Hatteras, North Carolina and Cape Canaveral, Florida. Cruises are conducted in spring, summer and fall during which 24 areas, ranging in depth from 4-10 m (13-33 ft), are sampled.

### ***Fishery Dependent***

Commercial seafood dealers are required to report the catch for fishers during the shrimping season to the SCDNR Fisheries Statistics Program, which compiles this information. A voluntary trip ticket system has been in place since the 1980's for shrimp and offshore finfish dealers who choose to participate in lieu of the monthly reports. For the shrimp fishery, weekly summaries of pounds landed by grade and number of trips are collected by area. Port agents visit those dealers on a weekly basis and monitor species compositions of catches at the docks. A 3 to 5 pound sample is sorted by species for as many grade categories and areas as possible and percent composition by weight is recorded. Those compositions are applied to the weekly trip tickets and used to generate a monthly species composition by grade and area to be applied to monthly summaries from dealers who do not participate in the voluntary trip ticket program.

Cooperative efforts with commercial fishermen provide information helpful in making management decisions. One of these cooperative efforts involves accompanying com-

mercial shrimpers prior to the opening of the shrimp season into closed areas. Several trawl tows are made ranging from 15-120 minutes in areas where historically white roe shrimp have been caught in good quantities. A subsample of five pounds is taken, 50 are measured (TL), ovarian development stage is recorded for female white shrimp, and the number of females and males is tabulated. The season opening date is set after it is determined that an adequate number of white shrimp have spawned. Opening on brown shrimp (when white shrimp are scarce) is based on size, and the anticipation that commercial sizes and quantities will be available on the shrimp grounds when the season is opened.

Another fishery-dependent monitoring effort occurs in conjunction with the channel net fishery. As white shrimp approach harvestable size in late summer, several channel net fishermen are selected to make 'test' channel net sets in the designated channel net areas. Total catch of shrimp, average lengths, and heads-on and heads-off counts are determined from these sets. An opening date for the channel net season is then determined. Other areas, such as Bull's Bay, are occasionally sampled via single trawl.

A recreational shrimp baiting survey is conducted each fall following the closure of the baiting season. The survey is mailed out to a random sample of shrimp baiting permit holders within each county of the state.

### **Findings**

Since the late 1950s, neither increased effort nor increased efficiency has significantly increased the overall landings of shrimp in SC. Landings have fluctuated dramatically over time (Figure 5), chiefly in response to abundance of shrimp that is largely related to winter temperatures and summer rainfall. Commercial landings in recent years have probably been lowered by reduced fishing effort that is symptomatic of lower prices caused by increased imports, particularly for the small and medium size shrimp. White and pink shrimp landings appear to have fluctuated more than brown shrimp. Recreational shrimp baiting is estimated to account for an additional 1.873 million lbs. (heads on) of white shrimp landed in the state in 2003. Aquaculture landings range from 8 to 19 percent of the total harvest.

### ***Trawl Fishery***

Penaeid shrimp caught by trawl constitute the most important commercial fishery in South Carolina, with approximately 3.9 million pounds of shrimp (heads off), including both white and brown shrimp, landed with an approximate market value of \$8.7 million in 2003.



*Figure 4. Commercial shrimp trawlers off the coast of South Carolina.*

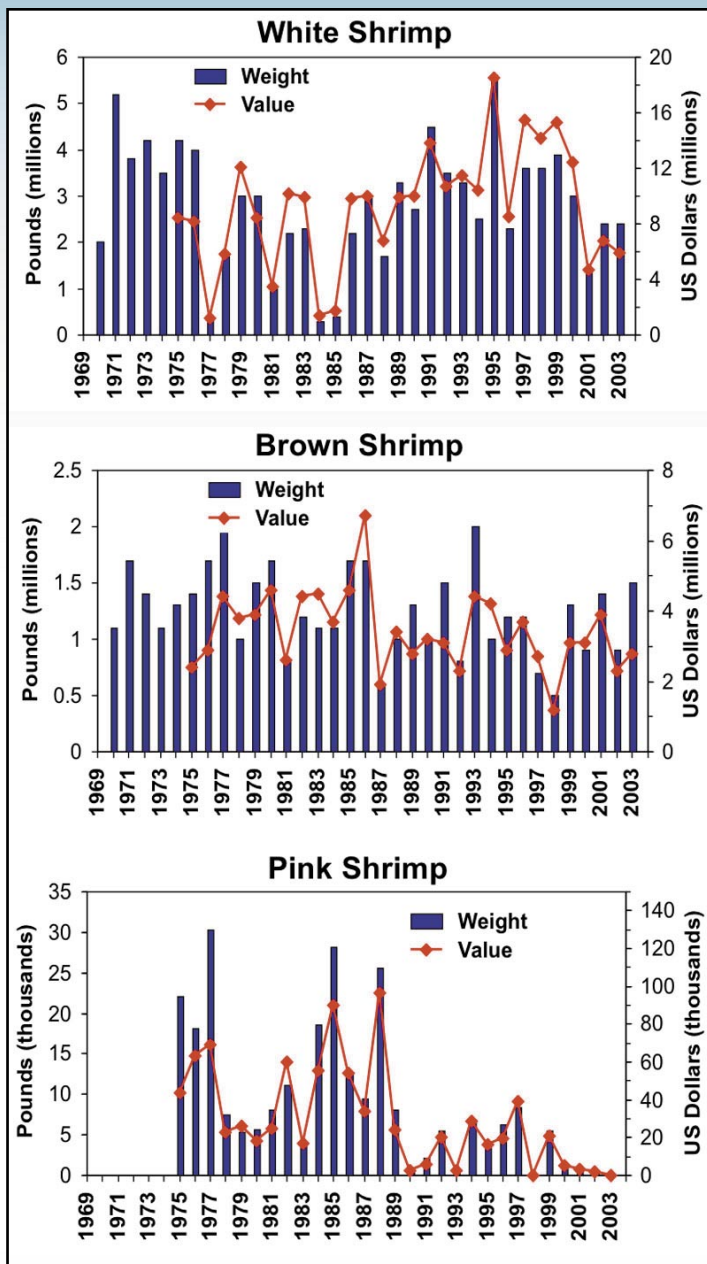


Figure 5. Weight (lbs.) and value in U.S. dollars for penaeid shrimp harvested in South Carolina.

In South Carolina, trawlers work in nearshore waters from spring to early winter. Brown shrimp landings generally peak in June and July while average commercial catch of white shrimp is greatest in fall (Figure 6). White shrimp landed in the spring, called "roe" shrimp, produce the shrimp harvested in the fall. Given good weather conditions in summer that includes normal rainfall, an average or above average fall harvest can be achieved with modest numbers of spring spawners. Examination of roe shrimp landings and fall harvest over time suggests that if there are at least 30,000 lbs landed in roe shrimp, then there should be an average harvest. Adequate summer rainfall can partially ameliorate the situation when spawners are not as

numerous. Conversely, poor summer nursery conditions can result in below average fall catches, even when roe shrimp are numerous.

### Recreational Harvest

Penaeid shrimp are also harvested by recreational users, primarily during the fall shrimp baiting season. Excellent opportunities for recreational shrimping occur in the tidal creeks of South Carolina. During most years, white shrimp make up the bulk of the recreational catch and are primarily caught from May through December. Brown shrimp, which

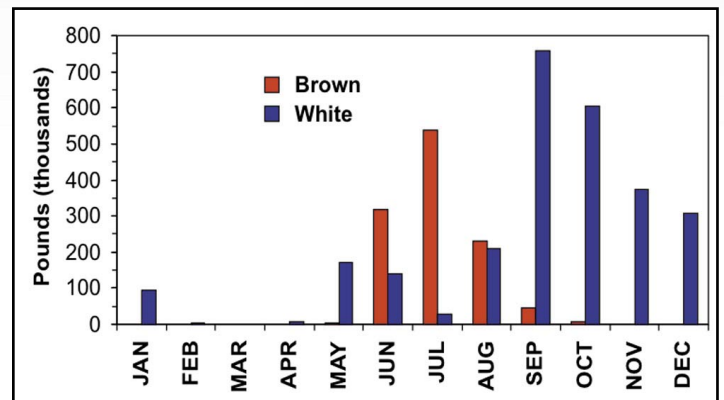


Figure 6. Average commercial catch of white and brown shrimp, 1979-2002.

are less abundant than white shrimp and comprise 30% of the harvest, are most abundant during June-August.

Although penaeid shrimp are caught throughout the length of most estuaries, individual species exhibit some preference for habitat based on salinity. Brown shrimp are usually more abundant near inlets and open bays where the water is more saline, while white shrimp tend to be found in mesohaline tidal creeks and brackish water areas. Because of their ubiquity in estuarine waters, shrimp may be recreationally caught in a variety of locations such as along beaches and river banks, from bridges and piers, and from small boats. An ebbing tide appears to be preferred for shrimping since shrimp move out of the marsh as the tide recedes and are concentrated in tidal creeks and shallow margins of open water areas.

A variety of gear types are used to catch shrimp, but the most common methods include cast nets, drop nets, and hand seines. Until the 1980s, the most prevalent method was the use of baited circular drop nets. In this method, shrimp that feed on the bait in the net are captured when the drop net is raised. Casting for shrimp over bait, however, has become the most significant method of recreational harvest in recent years (Figure 7). Shrimp baiting involves deliberate placing of bait, mixed with clay or mud, around



poles that are pushed into the sediment along shoal areas of a river or creek. Casting with cast nets begins within minutes after the poles are baited. Most shrimp baiting is done at night. Baiting and casting may also be done from docks.



Figure 7. Recreational cast netting for shrimp has increased in popularity in SC.

Shrimp baiting was most likely introduced to South Carolina from Florida. The popularity of this method spread from Beaufort and Jasper counties to Charleston County by 1984. Casting for shrimp over bait resulted in a large increase in the yield (19.6 times) compared to casting without bait. Due to major increases in the number of baiting participants and conflicts between baiters and the commercial fishery, regulations were passed in 1983 which made it illegal to sell shrimp taken over bait. In 1985, a catch limit per boat (50 quarts whole shrimp or 30 quarts with heads removed) was enacted. Additional restrictions were proposed in 1986 due to the eruptive growth of the fishery and increasing conflicts between commercial and recreational interests. The Shrimp Baiting Act of 1988 established a 60-day season, to be set by the DNR between September 1 and November 15, with a maximum of ten tagged poles per boat set not more than 100 yards. A 48-quart limit of heads-on shrimp per boat per 24 hour period was prescribed.

Since 1988, an annual post-season survey of a randomly selected sample of permit holders has been conducted. Over the first 10 years of data collection, the number of permits sold showed a steady increase from 5509 in 1988 to a peak of 17,497 in 1998, then declined to a current level of slightly less than 13,000 with 80-90% of the permit holders typically making at least one trip per season. During 1990-1996, annual effort fluctuated between 62,000-82,000 trips. After peaking in 1997 at 94,154 trips, effort generally declined to roughly 55,000 trips. Effort has generally been

greatest in the Beaufort and Charleston areas. Total landings (heads-on) have varied greatly between years (minimum of 0.59 million pounds in 2000 to 2.36 million pounds in 1997) with no long-term directional trend, although recent landings have been at the lower end of the range (Figure 8). Annual catches have not been closely associated with either the number of permits issued or the number of active permit holders. They have been most strongly correlated with the level of effort and catch rates. Both of these factors are in part functions of the absolute abundance of shrimp and their relative availability to baiters, with these elements strongly influenced by environmental conditions, both prior to and during the season. Rainfall during August and September has had a pronounced impact on the level of fall shrimp landings and their distribution between baiters and trawlers with the baiters' share being largest during dry years.

### ***Fishery Independent Monitoring***

#### Estuarine Trawl Survey

Annual variability in the average catch per tow of the fishery independent trawl survey largely reflects critical environmental conditions. Water temperature falling below 48°F (8.8°C) kills white shrimp. Mortality is certain when

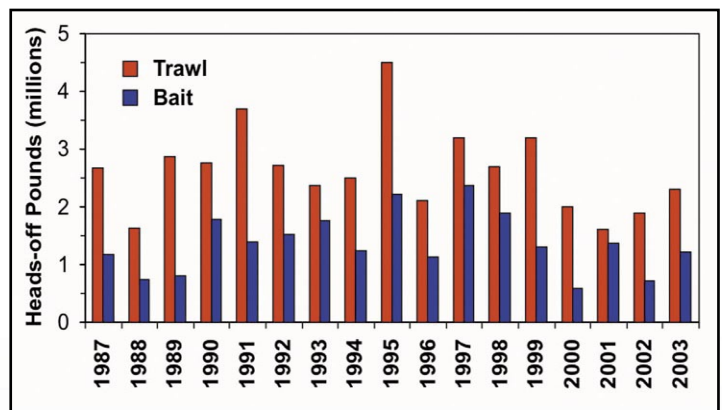


Figure 8. White shrimp landings (heads-off) for the commercial trawl (fall white shrimp only, August through January of the following year) and recreational baiting fisheries.

these lethal temperatures continue for several days. January–March are critical months for survival of spawning stock. There have been several years where catches of white shrimp in April were especially low following relatively cold winters (Figure 9). Recovery of the stocks by fall may occur if adequate numbers of spawners survive. However, in 1996 and 2001, low catches of spawners in April coincided with low catches in the fall, suggesting that loss of spawning stock due to cold winter temperatures was significant (Figure 10). Low salinities compound the problem when co-occurring with low temperatures.

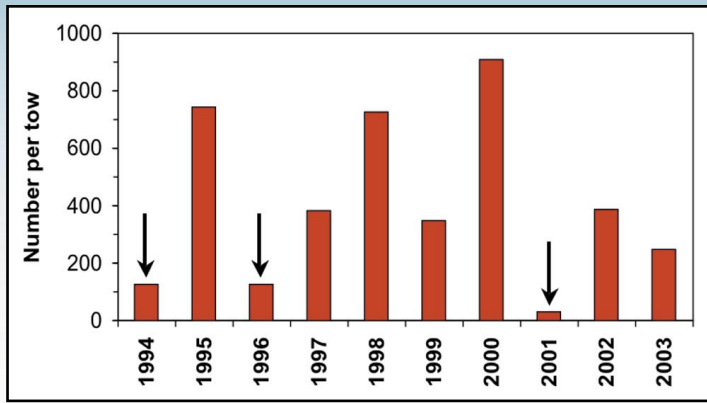


Figure 9. White shrimp collected in April by DNR trawls. Arrows indicate cold kills.

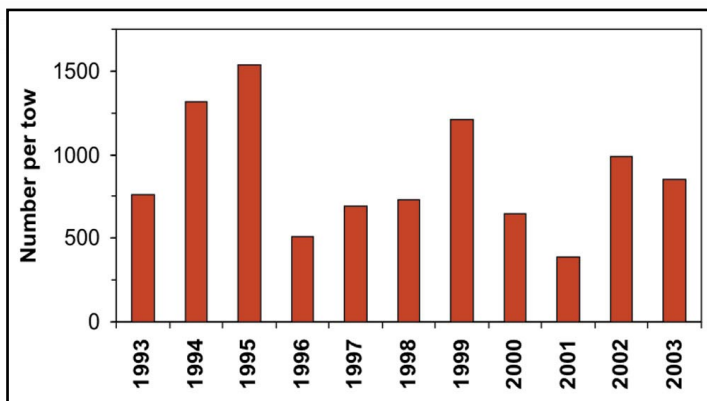


Figure 10. Number per tow of white shrimp caught in fishery independent surveys in fall.

In 2003, although temperature reached critical levels, at least some portion of white shrimp survived in Charleston Harbor. Catches in the tidal creeks near Charleston were slightly below average in 2003, perhaps influenced by a cold kill in winter, but the decline was not as great as was seen in 2001, when numbers fell to the lowest levels since 1988. Through April 2004, the average number of white shrimp in tidal creeks was the highest recorded during the survey (Figure 11).

Shrimp catches from the estuarine fishery independent trawl survey exhibited different temporal and spatial patterns of abundance during fall and winter 2002-2003. In Charleston Harbor during early January to mid January 2004, there was a good population of over-wintering shrimp. However, later in the month water temperature fell below the critical minimum for several days (Figure 12 A). After February, numbers declined but were not as low as those in the southern part of the state (Figure 12 B). Numbers have been reduced by cold-water temperatures in January, especially in areas from Charleston to Daufuskie Island (Figure 12B). The abundance of shrimp collected in April 2004 was 82 % greater than the abundance observed during the same period

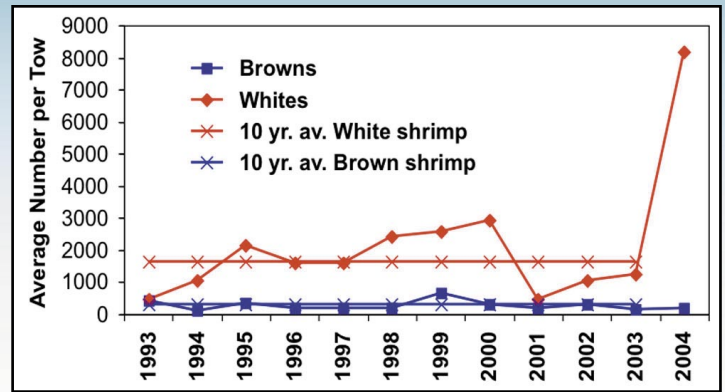


Figure 11. Catches of white and brown shrimp with trawls in tidal creeks near Charleston, SC.

in 2003. Collections made in spring 2004 indicated there were an adequate number of spawners to produce a normal fall crop in 2004 if weather conditions are favorable. The poor survival in areas south of Charleston following cold winter temperatures is most likely due to the shallowness of rivers and less river flow. It is unknown whether some portion of this stock could have moved offshore and south along the coast, thus surviving to spawn in other regions.

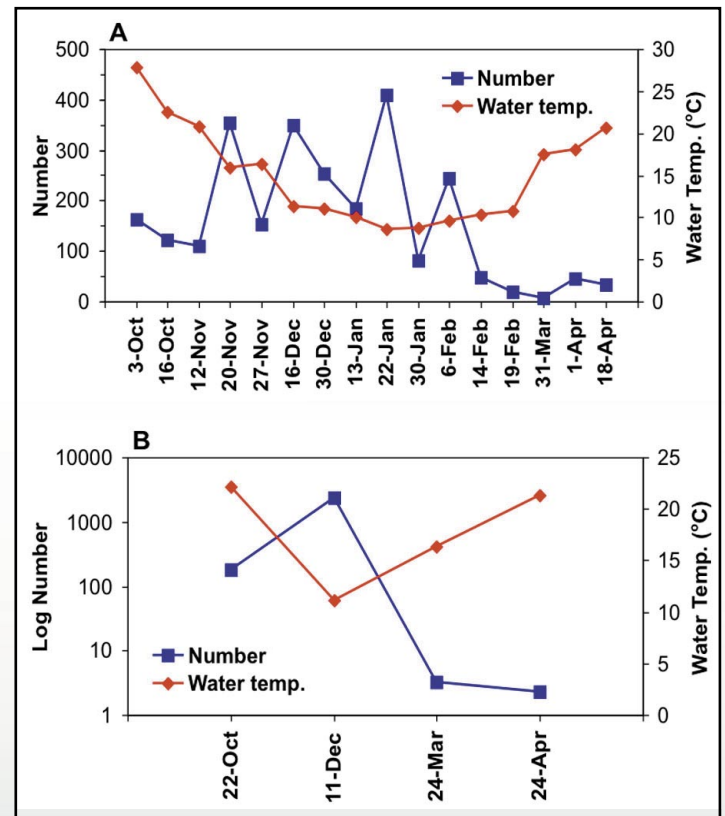


Figure 12. Average catch per tow of white shrimp and water temperature from fishery independent trawls, October 2003 through April 2004, in Charleston Harbor (A) and south of Charleston (B). Note that scale for B is a log scale.

The CPUE of brown shrimp during 1979-2003, though variable, appears to have increased since 1988 (Figure 13). Given the high variability associated with trawl sampling and the uncertainty of the annual abundance of adult spawner population levels, it is difficult to know if this apparent increase indicates a real increase in the overall population of shrimp. Commercial landings through the same time period showed similar fluctuations, with an apparent increase in pounds landed in South Carolina (SCDNR unpubl. data). The best landings of brown shrimp since 1993 occurred in 2001. A comparison of annual CPUE between pink and white shrimp revealed that the highest period of catch for pink shrimp, 1984-1986, corresponded to the lowest catch of white shrimp (Figure 14). The peaks of abundance of the two species were similar in late summer and early fall (Fig. 15 B).

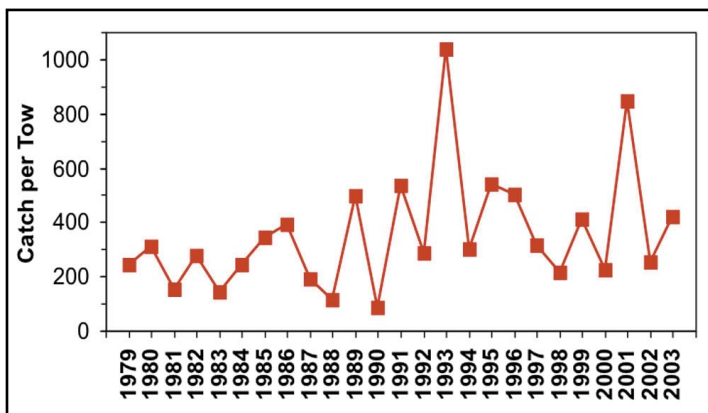


Figure 13. Average catch per tow of brown shrimp from fishery independent trawl catches.

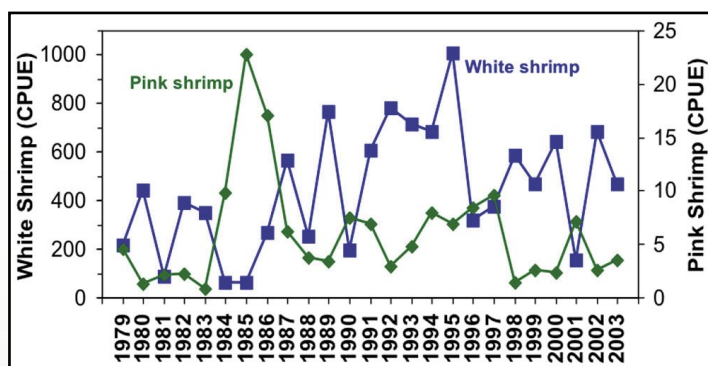


Figure 14. Comparison of average pink and white shrimp catch per tow from fishery independent surveys.

It is generally accepted that spring weather conditions have a great influence on inshore populations of brown shrimp. The low annual CPUE of brown shrimp observed during 1979-2003 was often associated with El Nino events, with eight out of ten years that bracketed the events of 1983, 1987, 1992, 1997 and 2002 having below average catch

rates. Of interest, the highest single CPUE of the time series was observed in 1993, at the end of an El Nino event. That year was characterized by cool spring conditions, but postlarval recruitment was relatively late, and warm temperatures by early May promoted rapid growth and apparently good survival of juvenile shrimp. El Nino events are associated with increased rainfall and river discharge. Excessive rainfall in early spring can negatively impact small brown shrimp by reducing habitat and survival of postlarvae. Cold temperatures can delay growth, making the smaller shrimp more vulnerable to predation.

The abundance of pink shrimp collected in SCDNR trawls has generally been low, although there has been some variability in abundance. Pink shrimp were in greatest abundance from 1984-86. The relative abundance of white shrimp was at its lowest level during that period, having been impacted by cold temperatures. During 1984-1986, pink shrimp had much greater than normal abundance at several stations. This suggests some expansion into areas normally occupied by white shrimp. From 1989 through 2000, white shrimp populations along the southeastern Atlantic coast were at high levels (NMFS commercial landings data). During this period, pink shrimp were primarily collected at three stations in South Carolina, two of which were large (> 500 m width at mouth) creek systems, containing areas of "live" bottom (sea whip and sponges) and dead oyster shell.

White shrimp have been relatively evenly distributed along the coast in most years. Pink and brown shrimp appear to be most abundant at stations located in or near Charleston Harbor. Pink shrimp were least abundant at low salinity stations.

The three species also exhibit seasonal differences in relative abundance. Brown shrimp are taken mostly from May-August, with 77 % of the total taken in June and July (Figure 15 A). White shrimp are most abundant from August through December, while pink shrimp are most abundant in trawls in April-May and August-October (Figure 15 B). Size differences were also evident by season. Brown shrimp increased in size from May into June. Young of the year white shrimp first appear in June in nursery areas and increase in size from July through August. Penaeid shrimp use the shallow (0-10 meter), mid-range salinity (8-15 ppt) areas of estuaries as their primary nursery habitat. This habitat is common south of Winyah Bay, which may account for the higher abundance of shrimp in this region when compared to areas north of Winyah Bay (McKenzie et al. 1980). The southern sounds of St. Helena, Port Royal, and Calibogue are among the most productive of the South Carolina estuaries.



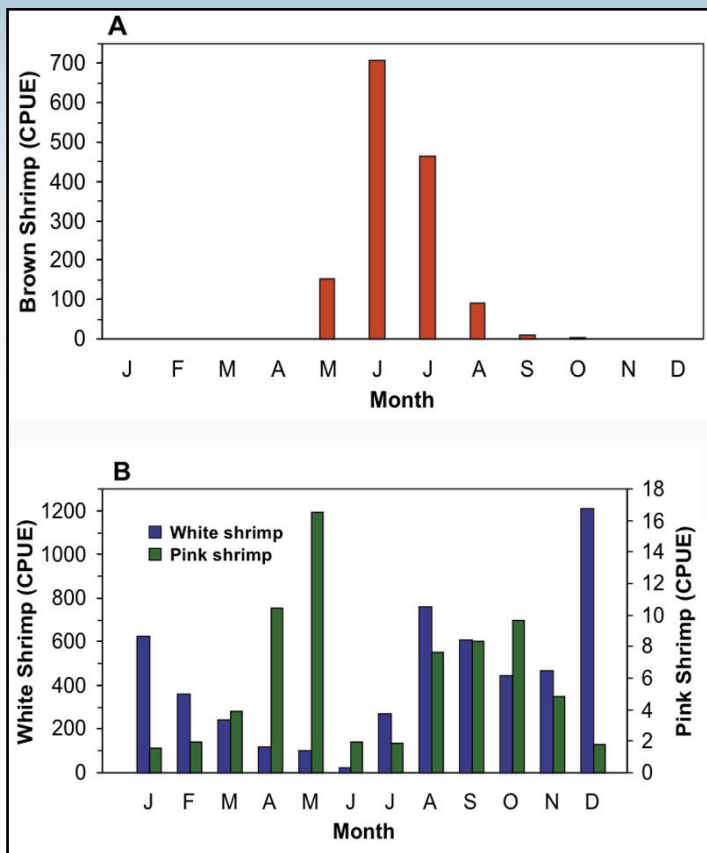


Figure 15. Average catch per tow of brown (A), white, and pink shrimp by month from the estuarine fishery independent survey.

### Coastal Trawl Survey

White shrimp were the most abundant shrimp collected in the coastal nearshore SEAMAP survey. The annual catch per tow of white shrimp in 1999 was the greatest in the duration of the survey. Abundance was highest in fall collections. Catches were highest off South Carolina. Ripe females and males were most abundant during spring.

Brown shrimp ranked as the second most abundant shrimp caught in the SEAMAP survey. Record catches occurred in summer 2000. The overall seasonal pattern of abundance of brown shrimp in the nearshore coastal zone of South Carolina includes small spring catches, followed by large summer catches and moderately sized fall catches. Most males and females had well developed gonads in fall.

Pink shrimp was the least abundant shrimp species collected in the SEAMAP survey. Catches were not markedly different among seasons. The survey shows a decrease in the number of pink shrimp from North Carolina southward. Low catch rates, particularly in fall 2001 and 2002, may have reflected a lack of movement into the ocean because of severe drought and high inshore salinities.

### Management

The penaeid shrimp fishery is managed by the South Carolina Department of Natural Resources, Marine Resources Division through licensing and seasonal opening of the fishery. Commercial fishermen must obtain a trawlers license and a captain's license from the Licensing Office of the SCDNR. The license requires the fisherman to report landings and other fisheries data to the SCDNR to assist in management of the fishery.

The SCDNR has authority to open and close the fishery, based on monitoring activities by the SCDNR. To protect spawning white shrimp stocks, commercial fishing is not allowed during later winter and spring. Trawling for white shrimp generally begins in May but may be delayed to protect spawning stocks. Following especially cold winters, with low adult survivorship, opening of the season may be delayed until brown shrimp brown shrimp abundance and size are appropriate for harvesting in June.

In the decade of the 1980s, the shrimping seasons were opened for six years based on size and abundance of brown shrimp (and low abundance of spring white shrimp). However, in the period 1990-2003, due to relatively high abundance of spring white shrimp, seasons were opened on brown shrimp only in 2001, following a winter cold kill of white shrimp and subsequent closure of the U.S. Exclusive Economic Zone to shrimp trawling. The EEZ opening was based on past observations that brown shrimp generally reach commercial size by mid June, and the South Carolina and Georgia state waters were opened simultaneously based, in part, on size of shrimp in monitoring trawls.

### Management Issues Related to the Commercial Shrimp Fishery

There are a number of problems and conflicts between the shrimp industry and other resource users. These include competition for shrimp between commercial trawlers and recreational shrimp baiters, conflicts with recreational fishermen over the capture of species such as red drum and spotted seatrout, concern over catches of sea turtles, and the destruction of ecologically important live-bottom areas.

### Competition Between Commercial and Recreational Shrimping

During fall, recreational shrimp baiting occurs from early or mid-September to mid-November (Figure 16). During the two-month season, landings by recreational baiters may account for up to half of the shrimp landed during this period.



Figure 16. Recreational shrimp baiting in South Carolina.

Commercial shrimp fishermen predicted that capture of shrimp in estuarine nursery areas coupled with a major increase in baiting participants results in reduced catches by shrimp trawlers. Their concern is that many of the shrimp are captured prior to reaching the ocean where commercial trawling occurs. Seafood marketers have also expressed concern that baited shrimp are being illegally sold, resulting in loss of tax revenue, potential health hazards, and lost documentation of resources harvested. Other arguments against baiting focus on the belief that bait poles are a hindrance to navigation, law enforcement is ineffective in enforcing regulations and apprehending lawbreakers, and that territoriality around favored baiting locations is creating conflicts among fishery participants. Because the areas fished inside the estuary by recreational shrimp baiters are closed to commercial operations, commercial fishermen may face some increased effort and cost to harvest shrimp. Both fisheries harvested relatively large quantities of shrimp until the year 2000. Since then, harvests have been below average, impacted by long-term drought and a cold kill in 2001. Commercial trawling efforts have little direct affect on recreational shrimping because shrimp in areas open to trawling are unavailable to recreational gear types (primarily cast netting from small boats).

Proponents of baiting stress that their activity is not environmentally harmful and does not damage bottom habitat or enhance nutrient loads via bait input, that baiting is selective for commercial grade shrimp and results in little by-catch, and that baiting is a fair access to a common property resource. The licensing provision allowed the SCDNR to directly determine the number of permit holders. The number of licenses has increased over the years in the state as a whole, although there has been a decline in licenses sold since 2000 (Figure 17). Since inception of the license, a number of post-season surveys have been conducted to collect information on the fishery (gear, fishing practices,

and areas most frequently utilized) and its participants (residence location, household size, income level and occupation, and trip expenses). Participation and landing figures are evidence of the rapid expansion in popularity, growth, and impact of this recreational fishery.

#### Impact of Trawling on Bottom Habitats

The primary habitats utilized by adult white and brown shrimp are composed of mud, sand, and washed shell. These primarily soft-bottom habitats support communities composed of shrimp, crabs, clams, worms, and other small invertebrates. Unlike "live bottom" areas, the communities in soft-bottom habitats seem to be less heavily impacted by short term trawling activity.

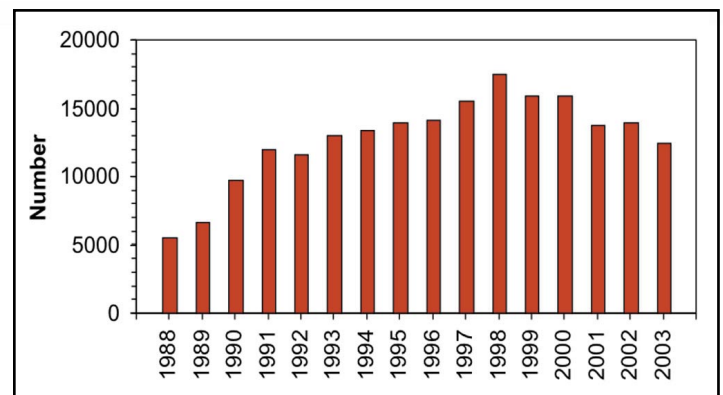


Figure 17. Number of baiting licenses sold in South Carolina.

#### **By-catch and Trawling**

The southeastern shrimp fishery may, in certain areas and at certain times, have an unwanted bycatch far exceeding the targeted shrimp catch. In recent years there has been a contribution to bycatch reduction by the industry through their use of TED's, and BRD's. Concerns over the magnitude and species composition of bycatch, discards, and incidental finfish mortality associated with shrimp trawling prompted a 1990 amendment to the Magnuson Fishery Conservation and Management Act that mandated the development of a Bycatch Reduction Research Program. A large number of sea turtles are estimated to be killed each year by commercial fishing. Inshore catch and mortality for shrimp trawlers is not known, but is thought to be significant. Turtle excluder devices have helped reduce mortality.

#### **Threats to the Resource**

##### **Economic Factors**

A major concern of U.S. shrimp fisherman is the escalation in foreign imports that shrimpers claim are hurting their livelihood due to unfair pricing practices. Shrimpers

from South Carolina as well as other states in the Southern Shrimp Alliance have charged that foreign shrimp producers are selling shrimp to the U.S. at lower prices than charged other nations.

Shrimp imports from Brazil, China, Ecuador, India, Thailand and Vietnam were valued at \$2.35 billion in 2002. In 2003, import figures for shrimp were 1.1 billion pounds valued at \$3.76 billion. During the period from 2000 to 2002, domestic wild caught shrimp dropped in value from \$1.25 billion to \$560 million. Imports accounted for 80 percent of shrimp consumed in the U.S. Other economic impacts to the South Carolina shrimping industry include the rising cost of fuel and the many environmental restrictions such as sea turtle excluders and by-catch devices that shrimpers claim impair their efficiency.

### ***Changing Land Use and its Impacts on Penaeid Shrimp***

A serious threat to the population is loss of nursery areas due to filling, dredging and draining of critical marsh habitat. Also, land use changes in upland areas adjacent to marshes alter levels of freshwater runoff and create greater salinity variations that affect habitat suitability for white shrimp. Although current regulations provide better protection to wetland areas, the upland areas adjacent to the tidal marsh habitats are still subjected to land uses that may have an impact on shrimp resources. Alterations to these upland areas, such as increases in the amount of impervious surface, agriculture and silviculture practices, or land clearing may increase the volume of surface water that runs off the land by reducing the storage capacity and retention time for rainwater. The resulting impact to nearby tidal marshes is larger salinity fluctuations, which may reduce the quality of the habitat for penaeid shrimp. This may, in turn, result in reduced abundance due to direct mortality, or movement to other habitats that may be less productive due to increased predation or reduced food supplies.

An additional impact associated with agricultural and urban development is the input of pesticides and other contaminants. Many of the pesticides that are used to kill or inhibit insects, are likely to have a similar impact on non-target species such as shrimp that utilize the creeks as nursery areas.

### ***Diseases***

There are a number of diseases and parasites that infect shrimp. These include viruses, bacteria, fungi, protozoa, helminths, and nematodes. The most common disease in local shrimp species are the single cell protozoan parasites

called micosporidians. These tiny animals invade various tissues of the shrimp and can cause the affected areas to appear grey or white, thus it is called "cotton" disease. Cotton disease has been noted in white and brown shrimp but seems to be most common in white shrimp. At times the infection rate for severe cases may reach 10 or 15 percent.

Shrimp in South Carolina have experienced a disease on their gills called "black or brown gill" since the summer of 1999. The disease is not harmful to humans and it is not clear how much it impacts shrimp, other than probably as an irritant. It is caused by a one celled parasite, and may propagate when the shrimp are stressed, such as during very warm weather, or after heavy rains. Generally it appears during the summer and gradually disappears by winter. In 2003, the disease was unusual in that it did not appear in high incidence until October, infecting about ½ of the white shrimp, then gradually diminished by December. Appearance of new shrimp viruses in South Carolina has increased concerns over the threat imported pathogens pose to native species. Although more attention is being paid to factors related to the health of marine organisms in our coastal ecosystems, much remains unknown about the disease status of the commercially significant native shrimp stocks in the South Atlantic region. Further studies are ongoing to better understand the impact of disease on the resource.

### ***Conclusions***

White shrimp catches in 2004 appear to be lower or comparable to catches in 2003, based on landings received to date. An adequate number of spawners survived the winter and should have produced a normal fall harvest, but trawling effort was probably reduced due to the lower price of shrimp. Brown shrimp landings were reduced compared to 2003 based on data received to date.

Inflation and declining shrimp prices have resulted in a general decline in the economic condition of the trawl fishery over the last ten years. An increase in foreign shrimp imports has had an effect on landings in South Carolina. The number of participants in the commercial fishery is declining although shrimp is still the most important seafood for the state. The tremendous growth in the shrimp-baiting fishery since 1985 has surprisingly not resulted in a major impact upon the trawler fishery's total harvest although some local impacts have been noted.





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Contributing author:  
Elizabeth Wenner  
[wennere@mrd.dnr.state.sc.us](mailto:wennere@mrd.dnr.state.sc.us)